Monitoring and Modelling the Occurrence of Priority Substances in Wastewater

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Introduction

In 2000 the Water Framework Directive (WFD), 2000/60/EC, was introduced and a group of 66 chemicals, including pesticides, polycyclic aromatic hydrocarbons, and metals were listed as chosen priority pollutants. The levels of these priority pollutants in the environment are regulated by set environmental quality standards (EQSs) and are affected by a number of emission factors including anthropogenic activities, population equivalents, and weather. In order for these EQSs to be enforced, regular monitoring of all water bodies must be carried out, a process which is both costly and time consuming. We have developed a model defining emission levels relating to priority pollutants occurrence in the environment. This is based on information collected from local authorities, Met Eireann and pollutant levels in waste water treatment plant (WWTP) effluents.

This study involved the analysis of samples from 8 WWTPs in both Cork and Dublin, Ireland, for priority pollutants, Table 1. These sites were chosen for their varying population equivalents, geographic locations, and main contributions, in order to make the final model of emission factors as comprehensive as possible.

Table 1 – Comparison of WWTPs included in this study, with the largest sites; Ringsend and Swords, located in County Dublin, and the rest of the sites located in County Cork.

WWTP:	Ringsend	Swords	Ballincollig	Bandon	Charleville	Fermoy	Mallow	Ringaskiddy
Population Equivalent	1,900,000	50,000	26,000	20,000	15,000	20,000	18,000	97,556
Main contributions	Industrial and domestic	Domestic and agriculture						Domestic and Industrial
Level of treatment	Tertiary	Secondary						None
Type of sample	Grab	Composite	Grab					Composite

Wastewater effluent was the chosen medium for this study for a number of reasons; Wastewater major point-source

Responsible for localised EQS exceedances

Often upstream of drinking water abstraction

Can be controlled

Few data on wastewater PS discharges

Will complement storm water studies, and inform targeted PS monitoring

Results

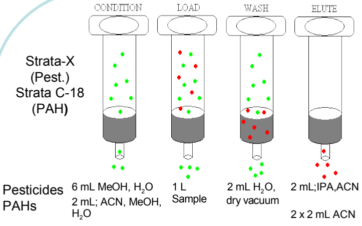


Figure 1 - SPE methods used for extraction

A 3 L sample of wastewater effluent from a treatment plant was divided into three 1 L aliquots. These were passed through SPE cartridges. Figure 1 shows the procedures for both pesticide and PAH extraction. This method adds a preconcentration factor of 1000.

A 3 L sample of wastewater effluent from a treatment

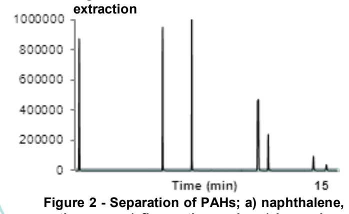
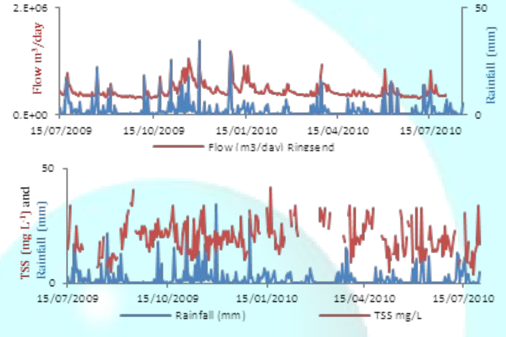
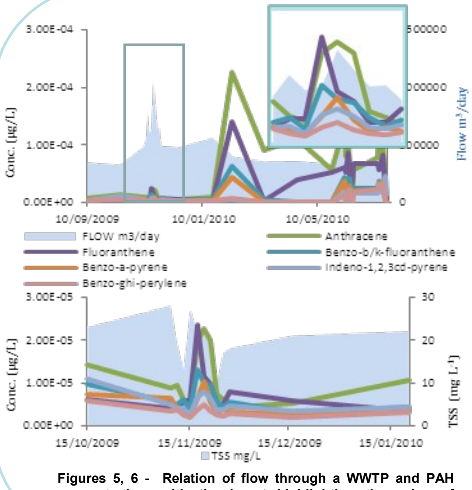


Figure 2 - Separation of PAHs; a) naphthalene, b) anthracene, c) fluoranthene, d + e) benzo-b- and benzo-k-fluoranthene, f) benzo-a-pyrene, g) benzo-ghi-perylene and h) indeno-123 cd-pyrene



Figures 3, 4 - Relation of flow through a WWTP and local rainfall. Then relation of rainfall to total suspended solids (TSS) levels in WWTP effluent.



Figures 5, 6 - Relation of flow through a WWTP and PAH concentration, with the insert highlighting the value of intensive sampling data. Relation of PAH concentration to total suspended solids levels in WWTP effluent.

Compared rainfall levels and total suspended solids (TSS) levels to PP levels in the WWTP effluent (Figures 5 and 6). Increased rainfall can bring forward stale sewage in a flushing effect. PPs in wastewater greatly increase, sometimes 10 – 100 fold when compared to dry weather levels. This specifically affects PAHs with regard to road-runoff, with PAHs being released from motor vehicles as particulates which settle on the roads and are washed into the sewers during periods of rainfall.

Increased rainfall and thus increased TSS content the PAH levels increased, but we can see that the lower log kow PAHs (eg anthracene) increased more than the higher (less water soluble) kow PAHs (eg. Bghi perylene) as they were likely adsorbed onto the solid material.

Parameter	AA EQS ($\mu g\ L^{-1}$)	LOD SPE-GCMS ($\mu g\ L^{-1}$)	Frequency (N=71)	Range	
				Min	Max
Naphthalene	1.2	0.0001	48	1.07×10^{-4}	0.035
Anthracene	0.1	0.0005	27	6.30×10^{-4}	0.013
Fluoranthene	0.1	0.0001	28	1.40×10^{-4}	0.0086
Benzo-b/k-fluoranthene	Σ=0.003	0.0001	29	1.20×10^{-4}	0.0044
Benzo-a-pyrene	0.05	0.0005	19	5.50×10^{-4}	0.0036
Indeno-1,2,3cd-pyrene	Σ=0.002	0.0005	35	1.55×10^{-4}	0.0025
Benzo-ghi-perylene		0.0005	20	5.90×10^{-4}	0.0032

CONCLUSIONS

We would like to acknowledge the Environmental Protection Agency for funding this research.